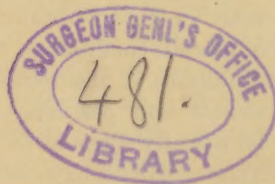


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SOME LIMITS
IN THE USE OF THE
OPHTHALMOSCOPE.



DISSERTATION.

SOME LIMITS IN THE USE OF THE OPHTHALMOSCOPE.

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Such very exaggerated opinions are occasionally expressed by those not familiar with the powers of the Ophthalmoscope, of the value of appearances in the fundus of the eye as indicating disease inside the cranium, that it has seemed advisable to point out some of the fallacies which exist as to their true relations, and to define the limits, so far as time will permit, of ophthalmoscopy, indicating similar or corresponding conditions of the brain.

The brilliant discovery, in 1851, of Helmholtz, the greatest of modern physiologists, by which the nervous expansion of the eye, with its beautiful network of vascularization, could be exposed to view and studied under perfectly natural conditions, was enthusiastically hailed as opening a rich field for both physiological and pathological investigations. I do not hesitate to claim for it almost unbounded limits in the determination of ocular disease. It is the creator of modern ophthalmological science. But does it do more than this, and how much more?

The opinion was very soon expressed that the circulation of the brain was shown by the circulation of the retina; that an hyperæmic or anæmic condition of the former was indicated by corresponding conditions in the retinal circulation, and after this other more remote and positive pathological conditions were claimed to be actually detected or proven by ophthalmoscopic observation. These opinions have been kept before the Profession principally by gentlemen working in the field of Neurology, but have become gradually less and less advanced, as the observations multiplied, by those making ocular diseases a study. Bouchut (1)* would have us believe the most varied cerebro-spinal diseases are each indica-

* See Bibliography at end of article.

ted by such especial changes in the eye that they may individually be recognized by the ophthalmoscope. He would show us a spinal (optic) neuritis, a neuritis from locomotor ataxia, from chorea, from diphtheria, from cerebral hæmorrhage and softening, from tuberculous, typhoid, and rheumatic meningitis, from hydrocephalus and thrombosis of the cavernous sinus, from encephalitis and the encephalitis of cardiac disease, from tumors of the brain and general diseases as syphilis, albuminurea, leucocythæmia, and indeed a neuritis resulting from paralysis of the 6th pair in consequence of certain kinds of epilepsy, hallucination, contusion of the brain, etc. If this were really so can it be doubted that ophthalmologists would not gladly recognize it, and utilize a field so obviously to their professional advantage?

Let us study, for a moment, the connections between the brain and the eye, which are, as you all know, the optic nerve and its sheaths, the retina being the terminal expansion of the former. The vascularization of the retina through the *arteria centralis retinæ*, does not hold nearly the same intimate relation with the brain, that its appearance in the fundus at the center of the optic nerve would suggest. It first enters the nerve at some fifteen or twenty millimeters behind the globe. It is one of the dozen, more or less, branches into which the ophthalmic artery divides, and the second in point of numeration. It is not given off from the ophthalmic artery until after this has entered the orbital cavity. The ophthalmic artery is given off from the internal carotid just as this enters the skull; and the next branches from this again, the anterior and middle cerebral and posterior communicating arteries, are not given off until after entering the Sylvian fissure. So far as the retinal artery is concerned, there is no more reason, from its origin, to suppose that changes in it would indicate changes in the brain, than that the lachrymal or palpebral branches of the same main stem should indicate them; nor is there any more reason to suppose the circulation of ophthalmic artery itself, to be influenced by changes in the terminal distribution of the internal carotid, than that variations in the temporal artery, would be indicated by corresponding differences in the circulation of the tongue.

Studying further the way in which the retinal artery gains access to the center of the optic nerve, we find it very distinct from any connection with the brain. Originally developed in the middle blastodermic membrane, while the brain and eye are devel-



oped from the external, their connection is formed during the process of development by a duplicature of the secondary optic vesicle wrapping around the artery, the applied surfaces then becoming fused together in the manner familiar to Embryologists as occurring in numberless organs and tissues. It is not a penetration through the nerve tissue of the vessel, but the nervous elements grow to envelope the artery.

The first detailed description we have of the phenomena of retinal circulation dates from Coccius (2) in 1853, though Van Light (3), a pupil of Donders, independently of Coccius' observations, published an article on the subject, in Holland, at about the same time. These were soon after followed by an exhaustive article by Donders (4) himself, reviewing both and criticising v. Graefe's (5) views on the same subject. Since then but little has been added to our knowledge of the phenomena attending the physiological circulation of the retina. By these observations it was shown: *first*, that there is a physiological venous pulsation, variable in force in different individuals within the limits of perfect health, and quite independent of changes in the general circulation: *second*, that there is no physiological arterial pulsation: *third*, that the latter may be produced by slight external pressure upon the eye ball, but that increase in the rapidity or force of the general circulation alone does not bring it into view: that, if present, it is evidence of increased tension in the coats of the eye only. It shows ocular conditions, but nothing else. Even the statements of such experienced observers as Quincke (6) of Berlin, Becker (7) of Heidelberg, and Landolt (8) of Paris, that aortic and mitral insufficiency is communicated perceptibly to the retinal circulation, causing arterial pulsation, must be taken guardedly. Dr. Loring (9) of New York, reports a case of pronounced aortic insufficiency, where "the murmur could be heard at a distance from the patient; there was tumultuous beating of the chest, with exaggerated pulsation in the vessels in the neck, . . . till they nearly entered the skull. The superficial vessels could be seen to pulsate . . . at the temples . . . Indeed the pulsation of the united vessels was so great that the head was constantly tremulous. Yet, notwithstanding this, there was not the slightest pulsation in the arteries of the retina." What Allbutt (10) means, therefore, when he says, p. 38, "arterial pulsation is never visible under any circumstances, natural or artificial," I cannot imagine; the phenomena having been minutely described by Jaeger (11), Van Light (l. c.), v. Graefe (l. c.), and

Donders (l. c.) in 1854 and 1855, and its mode of production, been more or less the subject of discussion ever since; unless it be, as might, by a stretch of imagination, be inferred from the context, that he is referring to normal eyes alone. Assuming this, however, and the statement is so broad that the concession can only be granted under protest, it is still untrue, as may be verified by any beginner in ophthalmoscopy. I am obliged to regard this either as an instance of inaccurate observation or of loose or forced generalization, to both of which this author is very liable, and which have brought his statements with regard to ophthalmoscopy in brain and nervous disease, certainly among ophthalmologists, into deserved disrepute.

We have been accustomed, based upon a long course of observation in various physiological conditions, as well as in disease and by direct experimentation upon the lower animals, to believe that variations take place in the cerebral circulation; we have founded thereupon a more or less complete system of rational therapeutics, and are most of us satisfied, from the fairly constant results obtained, that certain drugs produce certain definite alterations in the cerebral blood supply. It would certainly seem, if the assertions of those who claim that cerebral hyperæmia or its opposite, in diseases of that organ, are indicated and may be diagnosed by the ophthalmoscopic appearances in the retinal circulation, are to be accepted, that the ophthalmoscope would reveal, in the artificial cerebral conditions mentioned, the corresponding retinal circulatory changes, and by reversing the reasoning, would enable us with tolerable certainty to determine the condition of the brain by the appearances in the retina. Statements to this effect have been made with the utmost positiveness by various authors, but when we note the circumstances and conditions under which the examinations are made, details of the manipulations employed, and consider the fact that some, at least, of the observations are made to support a theory, we are compelled to be sceptical or to regard the methods employed as being so incomplete as to be worthless from a scientific point of view.

In striking contrast to most of these investigations is to be regarded the series of experiments made upon rabbits, by Dr. John Hunter Arbuckle (12), at the time clinical assistant at the West Riding Lunatic Asylum. These observations were all made by fastening the animal immovably upon Czermack's holder; the eye kept open by a spring speculum; a fixed ophthalmoscope used;

the eye observed and a drawing of the fundus made before the experiment was begun. During the whole experiment Dr. Arbuckle kept his eye constantly applied to the ophthalmoscope; the experimentation, namely, the application of the drug, etc., was made by an assistant; in every case, the amount given was sufficient in the end to cause death. The observation was continued until that took place, and an autopsy of the brain and eyes was afterward made. It would seem that every precaution necessary to obtain trustworthy observations was taken, and the investigation carried to completion.

Dr. Arbuckle used nicotine, atropine, aconitia, hydrate of chloral, nitrate of amyl, prussic acid, strychnine, hyosциamine, morphine and picrotoxine, nitrate of amyl and picrotoxine, atropine and picrotoxine, and hemorrhage, to produce death. *In absolutely no one single instance, from the administration of a drug, was there any change to be seen in the circulation of the fundus of the eye, during the life of the animal.* In the case of death from hemorrhage, where both carotid artery and jugular vein of the left side were divided and the animal died in a few seconds, the vessels of both eyes quickly lessened in calibre, became reduced to half their size, which condition remained after death. Changes also took place *after death* in the cases where nitrate of amyl, morphia and picrotoxine, nitrate of amyl and picrotoxine, and atropine and picrotoxine had been given. These changes were those of contraction of the vessels and a disposition of the column of blood to break up. In the face of these observations, does it not seem absurd to talk about the effect of a therapeutical dose of medicine as having an influence upon the circulation of the eye to be seen by the ophthalmoscope?

Dr. Hammond (13), of New York, states that Dr. Roosa noticed after the administration to him, Dr. Hammond, of a large quantity of quinine that the capillary circulation of the external ear, as also that of the membrani tympani, was greatly increased, and he further states that an increase in the retinal circulation, shown in a greater distention of the calibre of the vessels, was evident also, and from this he argues at length a corresponding condition of cerebral hyperamia. Now we must acknowledge an entirely different mechanical condition in the eye and retinal vessels from that of vessels distributed to the external skin. Theretinal circulation is constantly under the influence of a nearly steady hydrostatic pressure. And, as has been mentioned, the changes

which the retinal circulation shows in the pulsation of the arteries are due to a variation in that hydrostatic pressure, namely, to an increase of tension, those of the skin and membrani tympani not being subjected to this force. The same thing holds true for the brain, which does not fill out the skull as the vitreous body does the corneo-scleral coat, and which we all know physiologically pulsates under the influence of the heart as well as in unison with the respiration.

Without pretending to doubt the accuracy of Dr. Roosa's observation in that case, it must be stated that he has since reported to the New York Ophthalmological Society other cases in which a similar dose had been given and where he was unable to detect the corresponding changes in the retinal circulation. Doctors Loring and Curtis observed for six hours continuously, the retina of a man to whom they had given a large dose of quinine. They were neither of them able to detect the slightest differences in the retinal circulation during that time. It would seem therefore that the case mentioned must, so far as our present information goes, be taken as an individual idiosyncrasy rather than as establishing a law.

When we study the anatomical distribution of the arterio-venous capillary circulation of the nerve, nerve-disk, and retina surrounding it, as has been done of late years by Schwalbe (14), Leber (15), Michel (16), Schmidt (17), Wolfring (18), Manz (19), and others, it will be seen, that this has not the close anatomical relation with that of the brain which some authors, notably Galezowski (20), have asserted, and upon which the so-called cerebroscopists rest their main anatomical argument. The latter asserts an independent capillary circulation for the optic nerve and disk from that of the rest of the retina. According to Leber and Wolfring, the capillary circulation of the disk is derived from twigs of the central artery, given off after entering the nerve, and anastomosing intimately just behind the optic nerve entrance with branches derived from the short ciliary arteries entering the sclerotic in the immediate vicinity. Behind the point where the central retinal artery pierces the nerve, the capillary nerve circulation is derived from twigs sent back from the same artery anastomosing again with capillaries derived from the pia mater; this anastomosis is very complete and intricate; and although, as shown, there is a certain connection between the capillary circulation of the disk and that of the pia mater, still, before arriving at

the optic nerve entrance, it passes through such a net-work of communication with other branches not derived from the pia mater, that the influence of this latter portion is reduced to a minimum, if shown at all; and when observers, in describing the conditions of the optic nerve disk in brain disease, describe it as congested—as too red—as redder than usual—perhaps as swollen—they but state conditions which every Ophthalmoscopist, engaged principally with ocular disease, meets every day. There is not an Ophthalmologist in the country, of a fair practice, who does not meet almost daily, in eyes physiologically normal, and in persons in whom there can be no suspicion of brain trouble, functional or otherwise, precisely similar conditions to those described by the advocates of cerebroscopy as indicative of conditions of the brain. The variations in color of different optic disks are as manifold as the differences in color of the cheeks. A flush upon the cheek of one person may indicate disease, while in another it is a perfectly normal condition; and a comparative redness or flush of one disk is not necessarily an evidence of disease even of the eye under observation, unless it has been examined sufficiently often beforehand to establish its normal hue; how much more problematical, then, to consider from one examination of an individual supposed to be suffering from some disease of a remote organ that the appearances here indicate the nature of, or are even associated with, disease there. We must take into consideration the characteristics of the individual. These conditions of the eye we find also due to many local causes. The strain on the accommodation in Hypermetropia or Astigmatism, the inflammations associated with Myopia, are both potent causes for producing capillary congestions of the fundus. I meet them constantly among students, suffering *only* from errors of *refraction*.

When therefore Allbutt and others, writing from the standpoint of the effect of nervous disease upon the retinal circulation, assert a condition of anemia or hyperæmia of the central retinal vessels when the brain is supposed to be similarly affected; and when they go so far as to say, that hyperæmia or anemia of the retinal vessels indicates a condition of hyperæmia or anemia of the vessels of the brain, their statements show so meager a knowledge of the conditions influencing the retinal circulation, that they obtain credence only among those unacquainted with the details of the circulation of the optic nerve and retina, or not familiar with the variable appearances of the healthy fundus, and not posted in the literature.

While, therefore, acute changes in the cerebral circulation are

not to be reliably demonstrated in the retina or optic nerve disk, it is somewhat different with some of the chronic conditions. We find these to involve, more or less, interference with the lymphatic rather than the arterio-venous circulation. Of course the latter must participate; but from the experiments of Wadsworth and Putnam (21), and others, in obstructing the circulation of the jugular veins, it plays quite a subordinate rôle.

The investigators before mentioned, who have studied the finer capillary circulation of the nerve, have also taught us the peculiarities of its lymphatic circulation, though His had described the perivascular canals of the retinal vessels some time before. In ordinary dissections of the optic nerve we find a space called the inter-vaginal space, surrounding the nerve proper, enclosed between the neurilemma and the fibrous optic nerve sheath, and according to Schwalbe continuous with the arachnoid space inside the cranium. This space has been demonstrated by Schwalbe to be really composed of two quite distinct cavities, which he named the sub-arachnoid and sub-dural spaces respectively. The latter is very narrow, capillary in size at the anterior portion, and only to be detected by injecting the sub-dural space of the brain under constant pressure. The sheath thus demonstrated separating these two cavities corresponds to the arachnoid membrane of the brain. The optic nerve tissue proper is thus enclosed within a triple sheath, an external, firm, fibrous layer, continuous with the dura mater, the dural sheath; then a very thin membrane closely attached to this anteriorly, but still capable of being lifted off from it as above, the arachnoid sheath; within this again, next to the nerve, and sending processes into the nerve to surround the individual fasciculi, the pial sheath or neurilemma, and Axel Key and Retzius (22) have shown that the neurilemma, not only of the whole nerve but of the finer fasciculi, is permeated with fine, lymphatic spaces. Injections made underneath the neurilemma fill these spaces circularly around each fasciculus of fibres.

Now avoiding intentionally all discussion as to the differential diagnosis between the so-called choked disk and optic neuritis, and of their respective pathological significations of the importance of making ophthalmoscopic examinations for the purpose of eliminating these diseases from the question of diagnosis in any given case as Hughlings Jackson (23) has so well shown to be necessary, as being foreign to the immediate subject under discussion, which is, not to describe all the ophthalmoscope will show, but to indicate

its limitations, I submit that, *first*, the appearances of optic neuritis, including in that term the choked disk in its various degrees and stages, are found in too many diseases both intra—and extra—ocular, local and general, to be of reliable diagnostic value taken alone with regard to extra ocular disease, and *second*, that these actual diseases are quite different from the conditions found in the various forms of insanity classified as melancholia mania, acute or chronic, dementia, imbecility, or even epilepsy, in most of which we have been quite unable to demonstrate any characteristic pathological condition even in the brain tissue itself; how improbable then to expect to find such capable of recognition in so distant an organ as the eye.

Dr. H. D. Noyes (24) of New York, at the request of Dr. Grey, of Utica, examined ophthalmoscopically in 1872 sixty patients from the wards of the insane asylum there. The examination was made without knowledge of the mental or nervous conditions of the patients, and consequently without prejudice as to the ophthalmoscopic appearances to be found. In none of them, with one possible exception (to be referred to immediately), was there any appearance characteristic of the individual disease. The same appearances were presented under the ophthalmoscope whether the patient had dementia, chronic mania, melancholia, or other of the various alienist classifications. Dr. E. G. Loring of New York made a similar examination of the patients at the hospital for epileptics and paralytics on Blackwell's Island. In his verbal report to the New York Ophthalmological Society, he stated essentially the same thing as Dr. Noyes stated for his sixty insane patients at Utica. The one exception in both cases was in general paresis of the insane. And yet when we compare their statements of the appearances presented in this disease with those of the so-called cerebroscopists, it is as difficult as before to reconcile them. Dr. Noyes examined eleven cases. In all of these, with the exception of two, there was "hyperemia and infiltration of the nerve and retina. The striation of the retina near the nerve is often extremely pronounced and may render the edge of the nerve hazy or indistinct. The nerve is often opaque in texture, and may be of a slaty hue. In one instance, the nerve is found pallid, and doubt is expressed whether this may not correctly be called a sign of atrophy. It would not be easy to decide this point without testing the sharpness of sight, which was not done." Compare now these cautious hints

of a skilled and scientific ophthalmologist, with such loose statements as that of Dr. Hammond (25). "The senses with the exception of sight, do not often become materially affected. Atrophy of the optic nerve causes amaurosis or amblyopia. Ophthalmoscopic examination will very generally detect this condition of the papilla at a very early stage of the disease, together with retinal and choroidal anemia." Or that of Allbutt (page 193). It is a very remarkable fact that in almost all cases of general paralysis there is a tendency to atrophy of the optic nerve. The change seems sometimes to be one of simple atrophy quite from the beginning. In other cases and perhaps more commonly, the white changes are preceded by a state of redness, and the whole process then resembles some cases of tobacco amaurosis. The degenerative process begins about the end of the first stage, or the beginning of the second, and not infrequently results in complete amaurosis. When one takes the trouble to look over his tables, he will constantly find descriptions simply of "too white," "nutrition of nerves decidedly impaired," "marked atrophy invading the outer edge" (!) "disk pink," "edges unseen" (?) "disk seems a little redder than natural," "there may be a little atrophic tendency about some parts of the disk." Now I insist that these descriptions are absolutely worthless from indefiniteness, unless an examination of the eye had previously been made, and its physiological appearances established.

No ophthalmoscopist who wishes his reputation to be held as of value, will presume to state positively upon a given case that it is atrophy, without knowing accurately the conditions of vision. One may suspect that the patient has a defect of vision from the appearance of the nerve; but no ophthalmologist will positively assert that he has either incipient or perhaps absolute atrophy of the optic nerve, without having tested the limitations of the visual field, and color-perception, as well as central sharpness of vision. It is true, Dr. Noyes says further, "The uniformity in the aspect of the fundus oculi was so considerable that I soon learned to suspect from the ophthalmoscopic appearances what was the nature of the patient's malady." But he further says: "I am not to be understood as saying that I could thus diagnose general paresis." Dr. Loring stated that he learned after a time to pick out the cases of general paresis by a peculiar form of neuro-retinitis. He did not speak of any characteristic atrophy. Now these are statements of gentlemen having extraordinary

opportunities for investigating ocular disease. Both of them attached to the largest eye hospital but one in the world. They are accustomed to examine ophthalmoscopically many thousand eyes each year. When they express themselves thus cautiously, is it not wise for those having a less extensive field for observation to be equally modest in their assertions?

That ocular disease is frequently associated with intra-cranial disease no one pretends to deny. We have it at one stage perhaps as an optic neuritis, and later as an atrophy following or associated with various diseases of the brain, of which may be mentioned tumors, hemorrhage, cerebral abscess, hydrocephalus internus, softening; we have optic neuritis at the disk in intra-orbital tumors, cellulitis of orbit, deformities of skull, causing pressure at the optic foramen, and retro-bulbar optic neuritis. Also in scarlet-fever, typhoid-fevers, pneumonia, measles, puerperal-fever, alcoholisms, plumbism. *We have, as well, all these diseases without participation of the optic nerve.* The appearances of the optic nerve are not to be demonstrated ophthalmoscopically as essentially different in these different diseases, and are therefore unreliable as a means of diagnosis of the intra-cranial lesion. The differential diagnosis of the intra-cranial disease is to be made up from the concurrent brain or nervous symptoms, not by the presence of ophthalmoscopic appearances which bear no constant relation to any particular intra-cranial condition.

There may be atrophy of the optic nerve disk, a true papillary atrophy, following the inflammation of the nerve tract, without, so far as is known, any participation of the nervous center. There may be atrophy in disseminated sclerosis. It sometimes comes on as the result, as before stated, of tumors or of hemorrhages inside the cranium. We have it also in injuries by which the functional integrity of the nerve is cut off, but in no one of these are there diagnostic differences detectible under the ophthalmoscope. And when Allbutt says, in general paresis "that the atrophy of the optic nerve does not travel down from the optic centers and along the tracts, but exists as an independent patch of sclerosis does he not therein show the accidental nature of their connection?"

That the instrument is of great value in the study and examination of nervous disease, no one is more conscious than I am. But its usefulness is rather in the way of eliminating certain definite conditions; not in asserting the presence of a condition

which indicates any positive or characteristic brain lesion. Like the microscope it is simply an aid to investigation. The brain is the organ of the mind. The eye is the organ of sight. If the brain is diseased, it shows itself in some aberration of mental phenomena. When the optic nerve is diseased, the phenomena there are those of interference with the vision. Much more can be determined of the pathological condition by accurately investigating the finer details of interferences which the visual function as shown in limitations, central or peripheral, symmetrical or asymmetrical, binocular or monocular, transient or permanent of the visual field; the alterations of the color perceptions, etc., than in looking at the nerve with the ophthalmoscope. The subjective retinal sensations, or want of sensation of the individual affected are immeasurably more accurate than anything that the ophthalmoscopist can determine objectively. In a certain number of cases the two diseases go together; but there is no condition of either organ which indicates necessarily a definite affection of the other.

It seems strange that the advocates of so called cerebroscopy should be found not among ophthalmologists who are studying diseases of the eye in all phases, nor yet among the greater number of those who make diseases of the nervous system a specialty, to both of whom it would be of great value, to the former by enlarging their opportunities of practice, to the latter by adding an agent to their means of diagnosis, or treatment, or prognosis, but instead be confined rather to a very limited number of enthusiasts, who claim to be able to see more than those who are much more familiar with the instrument. If there were anything positive in the study of cerebroscopy, the great number of physicians engaged in the study of mental and nervous diseases would certainly have brought it to much greater perfection than has yet been done. In order to expect us to accept their views the cerebroscopists must use some other argument than to present to us appearances with which we are perfectly familiar, in ocular disease or of no disease at all, and claim them as evidences of brain disease. They must establish a much more constant and characteristic connection than they yet have done, and eliminate the question of coincidence pure and simple.

That insanity, a functional manifestation of disease in the brain, could be detected by appearances in another organ whose sole function is that of vision, would seem to be too illogical to be

more than mentioned, to be denied. If the optic nerve is diseased, its manifestation is in interference with the organ of vision and only that. No one is justified in saying, that because a man is blind from atrophy of the optic nerve, that he therefore has a disease of his brain, and there is very little differentiation to be made between the different forms of atrophy when confirmed. If he has disease of his brain, it is simply a coincidence. Few persons with diseases of the brain, nor indeed but a small proportion of them have any defect of their vision. Where blind persons have diseases affecting the nervous system in general, the blindness is because there is in addition, an especial and local affection of the retina or optic nerve; but this especial or local affection does not establish the general disease as fatty degeneration, nor varicose hypertrophy of the retinal fibres indicate Bright's disease of the kidney.

It is pertinent here to refer to a discussion in the New York County Medical Society (26) a few weeks ago, in which several of the prominent ophthalmologists of that city took part, and in which the unreliability of ophthalmoscopic appearances in determining cerebral disease was insisted upon by all. Dr. C. R. Agnew said, "That we might by looking into the eye with an ophthalmoscope tell whether the brain was congested or not, he did not believe as a rule, was true." Dr. C. S. Bull said, "The diagnosis of the inflammatory conditions of the optic nerve, and inferentially, corresponding conditions of the brain, had been for most part made by persons who were not sufficiently acquainted with the instrument to diagnosticate any of the more delicate affections of the eye. He thought it important that the general practitioner should know how limited the ophthalmoscope was as a cerebroscope." Dr. O. D. Pomeroy said, "The only method by which the eye could be examined exhaustively was the upright, and that could not be practiced skillfully without understanding how to diagnosticate refractions. No man could make a thorough ophthalmoscopic examinations without such ability, and he knew of no one who possessed the requirement except ophthalmoscopic surgeons. Ordinarily, neurologists were unable to state whether or not there was any disease in the eye."

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